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MODERN MARITIME TRADE WARFARE

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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Paper Abstract

Modern Maritime Trade Warfare

Due to an arguably decreased likelihood of total war and the recent focus on the reduction of collateral damage, the techniques used to affect maritime trade in past conflicts become less likely to be used and less desirable strategically. Without the willingness or ability to sink shipping on a large scale, it seems the modern merchant fleet is less vulnerable to the effects of maritime trade warfare. However, this paper argues that effective and timely use of modern capabilities and techniques against an adversary's maritime trade provides the user with significant negotiating leverage during a limited war. Diplomacy in support of Maritime Interdiction Operations, cyber operations against enemy shipping infrastructure, the use of Maritime Exclusion Zones to interfere with shipping networks, and GPS jamming or spoofing of merchant vessels are discussed and analyzed for potential effectiveness. Finally, recommendations are made to allow the operational commander to prepare in peacetime for modern maritime trade warfare.

INTRODUCTION

Throughout history, maritime trade warfare has been diverse in both the ways it has been practiced and the results it has achieved. Commonly referenced examples of this form of warfare occurred during World Wars I and II. In the First World War, over 10 million tons¹ of Allied and neutral shipping was lost due to commerce raiders, mines, and most notably, unrestricted use of German U-Boats. While these new maritime trade warfare capabilities were incredibly effective at sinking commerce, they also had the unintended consequence of drawing the United States into the war² which contributed to the German defeat. In World War II, submarines again played a critical role in maritime trade warfare, this time effectively employed by the Germans and the United States. An example of unlimited warfare, combatants on both sides violated the 1936 London Protocol by ruthlessly attacking merchant shipping without first accounting for the safety of crew members and passengers.³ The most effective of these campaigns was conducted by the United States against Japan. As the Imperial Japanese Navy lost its ability to counter American submarines, the island nation was essentially isolated and starved of essential war-making and survival resources.⁴ More recently, the Iranians and Iraqis conducted maritime trade warfare against each other's oil exports in the Arabian Gulf during the Tanker Wars of the late 1980s. Surface-to-surface missiles, air-to-surface missiles, and mines were employed in an effort to damage the opponent's economy and influence the decision making process of enemy leadership.⁵ These actions led to a 25 percent drop in commercial shipping and a sharp rise in the price of crude oil.⁶

Due to an arguably decreased likelihood of total war, changes in international law, and the resultant legitimacy concerns, the techniques used to affect maritime trade in past

conflicts become less likely to be used and less desirable strategically. Without the willingness or ability to sink shipping on a large scale, it seems the modern merchant fleet is less vulnerable to the effects of maritime trade warfare. However, this paper will argue that effective and timely use of modern capabilities and techniques against an adversary's maritime trade provides the user significant negotiating leverage during a limited war.

Several tools available to the Joint Force Commander (JFC) will be considered to prove this thesis. This list of tools is not intended to be all-inclusive, rather it will prioritize those tools that are most likely to be politically acceptable and provide the most effect over the shortest time. Each tool will be analyzed through examination of foreseeable positive and negative consequences of its use. In order to better illustrate how these tools could be used against an adversary, each tool will be applied to a hypothetical scenario -- a limited conflict against the People's Republic of China (PRC) over territorial disputes in the South China Sea. The argument will conclude by attempting to prove that the cumulative effect of the use of these tools against an adversary's maritime trade would be sufficient to affect the calculus of its decision makers. From this, several recommendations will be made to the JFC regarding what actions should be taken in peacetime to prepare for a robust maritime trade warfare capability to be used as needed in future conflicts.

For the sake of clarity in our PRC conflict example, several assumptions are made. First, the PRC has displayed military aggression against one or several of our allies in the region in an attempt to settle disputes over territory in the South China Sea. In this hypothetical scenario, whether by treaty or otherwise, U.S. policy makers have decided to intervene. In an effort to avoid escalation, kinetic strikes against mainland China are currently off the table. Maritime trade warfare techniques conducted in accordance with

international law and national guidance are acceptable as long as they do not significantly risk escalation or loss of civilian life. Before proceeding with the analysis of tools available to the JFC, it is important to show why formerly effective tools are no longer acceptable.

Many years ago, nations used privateers to conduct commerce warfare at sea.⁷ A privateer was an individual hired by one belligerent to capture the commerce of another belligerent. His fee was paid via the captured goods or "prize money." Since privateering was abolished,⁸ the most effective techniques against maritime trade have involved use of kinetic weapons against merchant vessels. As the examples of both World Wars and the Tanker Wars showed, commonly used weapons are mines, missiles, or torpedoes. All of these weapons are intended to, or run serious risk of sinking the targeted vessel or sometimes unintended vessels. As previously discussed, the 1936 London Protocol prohibits the destruction of an enemy merchant vessel without first assuring the safety of passengers and crew. There are several exceptions to this international law, for example if the vessel is actively resisting search or capture or if it is sailing under convoy⁹ it can be attacked without warning. However, the potential for escalation toward total war combined with the likely effects on international public opinion make this an undesirable option in today's climate.

While the formerly used techniques of maritime trade warfare are apparently now irrelevant in a limited conflict, the potential ability of maritime trade warfare to affect the calculus of decision makers is actually more relevant than ever. Globalization and the world economic framework have created a larger dependence on seaborne trade than ever before, even for the most resource-rich countries. Over 90 percent of the world's trade travels by sea.¹⁰ Any significant disruption of seaborne trade has the potential to create huge monetary losses in relatively short periods of time. In the case of China, approximately 85 percent of

its trade moves across the seas. In monetary terms, ocean commerce amounted to nearly 10 percent of China's GDP in 2008, with a total value of over \$450 billion.¹¹ Meanwhile, the Chinese shipping fleet consists of over 800 vessels¹² with an estimated value of over \$15 trillion. The disruption or confiscation of just a small number of these vessels bears an immediate cost in the billions of dollars and an opportunity cost in the trillions of dollars due to lost profits from shipping.

In contrast, it can be argued that in a limited war, a belligerent simply cannot inflict enough monetary damage fast enough to influence the outcome of the conflict. Without the ability to sink merchant shipping, can remaining strategies amount to anything more than pin-pricks against a giant? While no individual tool is expected to be sufficient alone, each tool represents an incremental contribution toward influencing an enemy. The combined effect of all the increments would likely be sufficient to play a role in the outcome of some conflicts.

MARITIME INTERDICTION

A primary and historically established method for conducting maritime trade warfare is Maritime Interdiction Operations (MIO). In the context of this paper, the goal of this interdiction is to seize or deny the enemy the use of as many goods, vessels, and crews as possible.

Under international law, maritime forces have the right to approach and visit any vessel in international waters in order to verify its nationality. If the vessel is not flying a flag,¹³ or at the invitation of the master of the vessel, it may be boarded.¹⁴ Goods headed for the enemy of a belligerent and liable to capture include absolute contraband (supplies directly related to belligerent warfighting capability) or conditional contraband (foodstuffs,

construction materials, fuel, etc).¹⁵ Finally, vessels operating under an enemy flag, operated by a crew of enemy nationals, or owned by a company of enemy origin may be seized along with its cargo and crew.¹⁶

In practice, maritime forces would ideally operate in areas of high enemy merchant congestion and low protection capabilities. Corbett's study of fertile areas, both terminal and pelagic areas is useful in this regard.¹⁷ Terminal areas provide the highest likelihood of encountering enemy shipping, but also provide the highest risk of encountering enemy combatants. International chokepoints like the Strait of Malacca, Strait of Hormuz, or Bab-el-Mandeb provide a less risky, yet still profitable option. In order to avoid excessive risk of direct military conflict, care must be taken to patrol in areas safe from land-based enemy interference. Similarly, it would be advantageous to operate in areas not commonly patrolled by enemy naval forces. While it may be impossible to completely eliminate risk of naval confrontation against some countries, few countries have robust forward presence capabilities and are forced to leave their merchant fleets exposed when operating far from friendly shores. Accordingly, this tool would be most useful against nations with less capable navies.

An advantage of MIO in today's globalized environment, an enemy merchant marine has legal interests (owned, registered, operated) in more vessels than ever before, and since international law allows for their capture, the seas are richer with maritime targets than ever before. Furthermore, the seizure of these items, especially vessels and crews, can have a long-term and sustained effect on the enemy at low risk to friendly forces and relatively low risk of escalation or collateral damage.

Large-scale MIO can be resource intensive and time consuming, and the U.S. Navy and Coast Guard have limited ships and boarding teams to use in its execution. The use of these resources in MIO presents opportunity costs against other more traditional maritime tasks. Additionally, problems exist as to what to do with vessels once they have been captured. Secure ports for vessel storage and prize crews for vessel transport are issues that would need to be addressed.

Globalization also carries a negative consequence when conducting MIO as well as most forms of maritime trade warfare. Merchant vessels captured will likely also have ties to other countries, whether they be owned, operated, flagged by or contain goods originating from or heading to that country. The potential for undesired second and third order effects against friendly or neutral nations is significant.

If conducting interdiction operations against the PRC, there would be no shortage of shipping to interdict. China owns the world's fourth largest merchant fleet and only eight other countries have flagged more vessels.¹⁸ Meanwhile, its shipbuilding industry is growing quickly and will continue to provide a target rich maritime trade warfare environment. While it may be tempting to conduct MIO in the South China Sea or near the approaches to China's major ports, improving PLAN capabilities combined with a substantial land based air and missile threat make operations in this area excessively risky. Instead, MIO efforts should be focused near strategic waterways not typically patrolled by PLAN assets. The approaches to the Panama Canal, the Strait of Gibraltar, and the Suez Canal are areas of heavy shipping volume and are not traditionally patrolled by PLAN warships, although they are capable of operating there and interdiction operations may require efforts to obtain local sea control. PLAN forces may be more likely to defend shipping in the Strait of Malacca, Strait of

Hormuz, or Bab-el-Mandeb. However, China's heavy reliance on oil imports is a vulnerability that may be worth the risk, as Saudi Arabia and Iran are two of the three largest sources of crude oil for China.¹⁹ The terminal areas to other major oil producers that supply China, such as Angola and Venezuela, would also be worthy of exploration. Prize crews could be contracted to deliver captured vessels and crews to secure ports in Guam or the United States. Depending on the specifics of the conflict scenario, the Philippines, Japan, or Australia may be willing to allow the use of their ports to harbor captured vessels. Sea basing provides another option to the JFC, but would require security resources, especially if located in international waters.

CYBER OPERATIONS

Another way to conduct modern maritime trade warfare against an adversary in a limited war is to conduct cyber operations against its shipping industry. First, it is important to clarify that in this limited war construct, recommended cyber operations do not include cyber attack as recently defined by NATO's Co-operative Cyber Defence Centre of Excellence, in that it is "reasonably expected to cause death or injury to persons or damage or destruction to objects."²⁰ Attacks that could cause death or injury to enemy civilian mariners risk escalation and negative public opinion consequences and are therefore undesirable. Instead, the goal is to cause immediate and widespread economic hardship by using cyber network attacks (CNA) against an enemy's shipping industry. Naval Warfare Publication 1-14M defines CNA as "operations to disrupt, deny, degrade, or destroy information resident in computers and computer networks or the computers and networks themselves."²¹ Potential ways to accomplish this end would be through the use of malware, worms, denial of service, or information disruption.²² Network vulnerabilities are abundant and vary depending on

actors. Possibilities include port facilities' communication networks, utility systems, computer hardware, surveillance architecture, and information storage and retrieval systems.²³

The possibilities when combining cyber operational methods and targets are endless, but in an effort to illustrate this potential, a few examples are provided. Malware delivered to port facility computers could disable those computers and cripple the port facility's command and control structure. Similarly, a denial of service (DoS) attack could also cripple a port facility's command and control infrastructure. Finally, information manipulation software could be used to alter loading and destination instructions for large quantities of cargo.

There are several advantages to using cyber operations against an enemy's maritime trade infrastructure. First, it is inexpensive to develop and implement compared to traditional forms of maritime trade warfare. It has the potential to affect a large quantity of enemy shipping over a short period of time with little risk of escalation. Furthermore, cyber operations can be fully planned and developed in peacetime without provoking potential enemies. At the outset of hostilities, developed cyber operations can be launched quickly without a requirement to move assets into theater.

There are also areas of concern when using cyber operations against an opponent in a limited war. Primarily, there are legal considerations including the concept of *jus in bello* -- do cyber operations qualify as "war fought justly"?²⁴ At the moment, there is little international consensus on answers to the many legal questions that have arisen regarding cyber operations.²⁵ The recently released Tallinn Manual addresses many of the questions, but is not legally binding. For the time being, there are few international standards preventing a belligerent from conducting the discussed operations. Still, care must be taken

to satisfy the general principles of the Law of Armed Conflict: necessity, distinction, proportionality, and unnecessary suffering.²⁶ Particularly, cyber operations will be inherently difficult to conduct while operating within the principle of distinction. Care must be taken to distinguish between enemy forces (or contraband) versus the population (or legitimate shipping). Perhaps more importantly, with shipping becoming increasingly globalized, effort will be required to avoid harming neutral countries or using neutral cyber infrastructure for hostile actions.²⁷

Another disadvantage is that adversaries will likely have capabilities to detect and correct network issues. The key for friendly programmers is to devise programs that are difficult to detect and cause the most damage possible in the shortest amount of time possible. Finally, friendly policy-makers may not want to open the cyber "can of worms." An adversary may have similar offensive capabilities that can be used against friendly networks.

Even so, the Chinese maritime trade infrastructure provides numerous opportunities for effective cyber operations. Its operation center for the Asia-Pacific region is located in Taiwan and consists of a marine transit center, air freight center, and telecommunications center.²⁸ The associated Maritime Transport Network (MTNet) is integral to port operational efficiency through the use of information technology.²⁹ Similarly, the Maritime Information Communication System is an overarching information and communication system used to increase port efficiency and unity of operations.³⁰ Each of these discussed network capabilities present opportunities for joint commanders interested in maritime trade warfare. China's networked relationship with Taiwan suggests additional vulnerabilities worthy of investigation, especially in the context of a conflict over Chinese territorial aggression.

DIPLOMATIC EFFORTS

Diplomatic efforts in support of maritime trade warfare include leveraging international organizations to create unfavorable maritime trading conditions and convincing nations to deny an enemy the use of vessels, crews, and ports. International organizations such as the United Nations (UN) and the International Maritime Organization could take action against a belligerent designed to hamper its maritime trade efforts. A UN Security Council Resolution authorizing a blockade of certain goods is an excellent example. An enemy nation could also be denied provisions of free trade agreements by any international trade or economic organizations, thereby making trade more expensive. Meanwhile, increased globalization of the shipping industry provides opportunities to deny an enemy the use of ships, crews, and ports. Merchant vessels used by a nation are often owned by, registered in, or operated by interests from other countries. Diplomatic pressure applied in an effort to deny an enemy the use of these ships and crews could prove effective. The use of foreign ports for refueling and resupplying could also be inhibited with successful diplomacy.

Advantages to using diplomacy as a direct and indirect tool of maritime trade warfare against a belligerent include low cost and low physical risk. Widespread diplomatic success could also lead to heavy monetary penalties against an enemy. However, globalization and self interests make widespread success difficult, which is this course of action's primary disadvantage. In other words, asking another country to suffer damage to their own maritime trade in an effort to damage an enemy's economy will be a tough sell in some instances.

In the case of China, it will clearly be difficult to obtain significant international resolutions against them given their veto power in the United Nations and their growing

status on the international stage. However, significant leverage might be obtained by convincing other nations and intergovernmental organization like the Association of Southeast Asian Nations (ASEAN) to impose trade restrictions, including maritime trade restrictions, on China. The United States is easily China's top trading partner, a fact that presents coercive potential by itself. Of the next nine highest Chinese trading partners,³¹ the United States has alliances or strong relations with most including Japan, South Korea, Taiwan, Germany, Australia, Brazil, and India. Any cooperative maritime trading restrictions among these partners have the potential to cripple China's economy. Additionally, the United States could leverage its relationship with Saudi Arabia to deny PRC its largest source of critically needed oil. Finally, many Chinese-owned vessels are registered in other countries due to export, quarantine, and other regulations in China.³² The United States could pressure countries who register Chinese owned ships to either deny use for a period of time, or create conditions unfavorable for optimum use of those vessels.

MARITIME EXCLUSION ZONE

In an armed conflict, an "exclusion zone" is declared in an effort to contain the borders of an armed conflict and to limit risk to noncombatants who would otherwise put themselves at risk by traveling through a contested area.³³ In the case of maritime trade warfare, it can also have two desirable ancillary effects. First, a well-placed Maritime Exclusion Zone (MEZ) could force merchant shipping to find an alternate route, likely resulting in additional transit time, fuel and operating costs. Secondly, a vessel which proceeds through a MEZ out of necessity or otherwise forfeits its marine insurance.³⁴ Section 2e of the 1963 Maritime Insurance Act (the "war risk clause") prohibits operation of a vessel in a war zone or subjecting its cargo to destruction or capture. It specifically

addresses capture at sea and/or confiscation.³⁵ Taken as a whole, a MEZ could be placed in an area that forces enemy shipping to choose between extended transits costs or risk of capture without insurance.

The advantages of a well-placed MEZ include ease of application and rising insurance rates for an adversary. The United States would not need to seriously contest the given area more than what is required to give the MEZ credibility in the eyes of insurers and mariners. Additionally, delays caused by rerouting would cause a ripple effect to the maritime network. Vessels late to arrive in port disrupt the delicate schedule of the busiest ports and lead to increased crowding, confusion, and inefficiencies, all of which cost money.

The establishment of a MEZ also carries some negative consequences. Friendly and neutral shipping would also need to alter their routes and pay higher insurance rates. Ideally, a MEZ must be placed where it would have the maximum impact on enemy shipping, but minimum impact on friendly and neutral shipping.

A MEZ in a potential conflict with China may be placed over certain areas of the South China Sea or over the entire South China Sea. Areas surrounding the busy ports of Tianjin, Qingdao, Shanghai, and Hong Kong³⁶ would make excellent areas to designate as exclusion zones. An exclusion zone the size of the South China Sea would clearly be internationally unpopular, but while the economic effects of this action would be felt by many countries internationally, no country would suffer the effects nearly as much as China.

GPS JAMMING/SPOOFING

Today's merchant shipping fleet relies heavily on Global Positioning Systems (GPS) for navigation. Accordingly, the denial of GPS capabilities to a merchant fleet could be an effective form of maritime trade warfare. David Last, a professor emeritus at the University

of Bangor, Wales and former president of the Royal Institute of Navigation recently wrote a paper on the vulnerabilities of GPS systems. In it, he concluded that a major shipping accident in the English Channel will occur over the next decade due to blocking of GPS signals.³⁷ During experimentation in the English Channel in an effort to prove this theory, vessels with their GPS jammed from shore installations reported "the display showed the ship traveling over land in Belfast, while we were plainly in the North Sea. And it was surprising how many other devices depended on the GPS working. The compass stopped working and the emergency communications system was knocked out."³⁸

The science around GPS jamming and spoofing is beyond the scope of this paper, however, it is important to understand a few basic principles before applying these techniques to maritime trade warfare. First, GPS jamming is creating a false signal designed to overpower the actual GPS signal and thereby render GPS unusable.³⁹ GPS spoofing employs a false signal so the user has an inaccurate depiction of present time or location.⁴⁰ Affected ranges are limited by line of sight, but can reach out to over 100km if either the target or jammer is airborne.⁴¹ Additionally, signals can be transmitted directionally or omnidirectionally.⁴² Finally, GPS navigation can be affected by military attack on the ground segment of a GPS network, the portion responsible for maintaining the system time, controlling the satellites, and uploading navigation data.⁴³

GPS jamming and spoofing could be conducted against a belligerent's maritime trade in either littoral or open ocean environments. In littoral environments such as straits or port entrances, GPS spoofing could have the effect of causing a vessel to collide with other vessels or could cause it to run aground, as USS Port Royal did in Hawaiian waters in 2009, largely due to GPS malfunctions.⁴⁴ A vessel running aground would cause a belligerent

nation to temporarily or permanently lose the benefits of the vessel and its cargo, impose the recovery costs required to free the vessel, and could possibly close a port or strait to additional traffic. GPS jamming or spoofing in open waters would likely cause a vessel to take suboptimal routes to its destination, increasing operational costs as well as disturbing established timelines and possibly creating a ripple effect to shipping operations.

Among the several advantages posed by GPS jamming and spoofing, it can be an inexpensive way to affect an opponent's maritime commerce, as GPS jamming equipment can be purchased for as low as \$75.⁴⁵ The physical risk to friendly forces employing this technique is low. Further, through the use of space technology, it has the potential to be used on a widespread basis to have maximum effect.

However, jamming techniques could be difficult to selectively direct at an adversary and may have adverse effects against friendly or neutral shipping. Groundings in international straits may be undesirable. Further, grounded or colliding vessels could have adverse environmental effects if they resulted in oil spills, for example. Damage to protected reefs could be of equal concern. Additionally, reliance on GPS technology is a vulnerability for friendly forces as well, and could similarly be used against the United States and its allies.

In a maritime trade warfare example against the PRC, jamming or spoofing could be used in selective areas such as the Strait of Malacca or the Philippine Archipelagic sea lanes. GPS spoofing in the entrances to major Chinese ports like Shanghai, Qingdao, and Tianjin could have the added benefit of creating bottlenecks. Finally, China's increasing reliance and investment in homegrown satellite technology⁴⁶ present opportunities to selectively target Chinese vessels.

SUMMARY

While it is unlikely that maritime trade warfare will be the sole decisive effort in any armed conflict, the effective and timely combination of several of these modern tools as well as some other tools not discussed such as blockades and special operations against ports and vessels can have a cumulative effect and influence the calculus of an enemy in a limited war. The economic climate we live in today presents opportunities for a belligerent employing maritime trade warfare to impose pain on an enemy in a short amount of time with a limited force, as today's "shippers are operating to tighter and tighter margins."⁴⁷

The tools of modern maritime trade warfare could provide a cumulative effect against an enemy. The seizure of merchant vessels, goods, and crews have immediate impact by denying the enemy the use of those goods or the revenues gained by those goods. Additionally, the loss of vessels and crews impose a future cost of lost revenues and possible replacement costs. Meanwhile, the use of diplomacy and the denial of global trade benefits from other nations and intergovernmental organizations impose both immediate and long term penalties for an enemy. Finally, tools such as cyber attacks and GPS spoofing disrupt the delicate system of international shipping. Resultant inefficiencies are costly and damaging to an enemy's economy.

Here again, a look to an example of a limited war with the PRC provides a convincing study. Many economists argue that China's surging economy is largely artificial and is a bubble waiting to burst.⁴⁸ An effective campaign against China's maritime trade, especially its vulnerable oil imports, could provide the pin that bursts the bubble. Professor Milan Vego's writings on China are insightful in this regard: "(China's) heavy reliance on imported oil and other raw materials is one of the PRC's greatest weaknesses in the event of a

conventional war. The country is almost helpless in protecting its overseas oil-import routes. This great vulnerability cannot be resolved easily, if at all. The PRC's economy can be crippled by interrupting the flow of trade through several critical chokepoints..."⁴⁹

Additionally, techniques used to delay and disrupt shipping networks in China could have a devastating effect. In a survey of China's logistic industry conducted by Zeyan Zhang and Miguel Andres Figliozzi,⁵⁰ managers were asked about specific costs generated by disruptions and delays. Forced price discounts, rebates, penalty payments, cancellations of orders, and return of cargo, among other problems, were identified and led to increased costs of up to 42.9 percent for importers and 37.1 percent for exporters.

Even in this hypothetical example against the PRC, a nation with considerable military, economic, and diplomatic means, modern maritime trade warfare can be effective in a limited war. Nations with lesser means would be considerably more vulnerable to several of these techniques.

RECOMMENDATIONS

As Professor Vego suggests in his writings about maritime trade warfare, success depends on what actions are taken during peacetime.⁵¹ With that in mind, the following is a list of recommendations for an operational commander designed to maximize the effects of previously discussed maritime trade warfare techniques.

First, to maximize potential for maritime interdiction operations, MIO teams in addition to the teams required in any deployable naval vessels need to be identified and trained. Teams qualified to board non-compliant vessels must be available for quick deployment. Further, the issue of prize crews must be addressed in order to reduce manpower requirements for naval forces. If contracting is the solution, details of the

contracts must be determined prior to conflict. Ports must be identified and readied for the storage and protection of seized vessels. Agreements between U.S. and foreign governments regarding prize crews and ports must also be drafted in advance of conducting operations.

Operational commanders should also identify cyber vulnerabilities of shipping networks for potential adversaries. Cyber teams can then develop software to attack these vulnerabilities. At the outbreak of hostilities, an operational command should have these capabilities ready to employ immediately.

Operational commanders should also analyze vulnerabilities of potential adversaries in terms of globalized shipping networks. Who owns the vessels used by an adversary's maritime interests? Where are these vessels flagged? Who operates these vessels? Diplomatic pressure brought to bear in any of the areas could have a crippling effect on enemy maritime trade. Similarly, what economic organizations can be leveraged to incur additional costs to a belligerent?

Another peacetime activity that can be completed in advance of maritime trade warfare operations is to identify potential areas for designation as Maritime Exclusion Zones. Areas selected should be strategically located in order to cause enemy merchant vessels to be faced with a choice to travel suboptimal routes or risk traveling through dangerous waters without maritime insurance. Commanders should also focus on areas that will have maximum effect on enemy merchants and minimal impact to friendly and neutral shipping.

Finally, commanders should identify GPS jamming/spoofing plans for potential adversaries. Preparations should include purchase of required equipment and training in its use. Decisions should also be made as to potential locations for employment, taking into

consideration possible effects of jamming/spoofing operations in those areas. Adversary satellite capabilities and networks should also be analyzed for wholesale vulnerabilities.

While the days of unlimited maritime trade warfare have likely disappeared forever, a new set of tools has emerged in the modern context. Minor peacetime commitments in preparing for effective and coordinated use of these tools has the potential to influence the outcome of today's limited wars.

NOTES

1. Hans Joachim Koerver, "German Submarine Warfare 1914-1918 in the Eyes of British Intelligence," *British National Archives*, May 2012. xii.
2. Douglas C. Peifer, "Maritime Commerce Warfare. The Coercive Response of the Weak?" *Naval War College Review*. Newport: Naval War College Press, Spring 2013. 83.
3. United States Department of the Navy. *The Commander's Handbook on the Law of Naval Operations*. Naval Warfare Publication (NWP) 1-14M. Quantico: Navy Warfare Development Command, July 2007. 8-10.
4. US Department of the Interior. "War in the Pacific: The Pacific Offensive. The Silent Service: Submarines in the Pacific." Accessed 2013. http://www.nps.gov/history/history/online_books/npswapa/extContent/wapa/guides/offensive/sec6.htm.
5. Robert S. Strauss Center for International Security and Law. *Tanker War*. Accessed 2013, <http://strausscenter.org/hormuz/tanker-war.html>.
6. Ibid.
7. Douglas C. Peifer, "Maritime Commerce Warfare. The Coercive Response of the Weak?" *Naval War College Review*. Newport: Naval War College Press, Spring 2013. 85.
8. Ibid., 105.
9. United States Department of the Navy. *The Commander's Handbook on the Law of Naval Operations*. Naval Warfare Publication (NWP) 1-14M. Quantico: Navy Warfare Development Command, July 2007. 8-11.
10. William Burke, "How the Navy Protects America," *Rochester Democrat and Chronicle*. 24 July 2012. <http://navylive.dodlive.mil/2012/07/26/how-the-navy-protects-america>.
11. Ocean Development Strategy Research Study Group, "China's Ocean Development Report," *State Oceanic Administration*, 2010. 227.
12. Maritime Administration. "Top 25 Flags of Registry." Accessed 15 December 2011, <http://marad.dot.gov>.
13. United States Department of the Navy. *The Commander's Handbook on the Law of Naval Operations*. Naval Warfare Publication (NWP) 1-14M. Quantico: Navy Warfare Development Command, July 2007. 3-4.
14. Ibid., 3-12.

15. Ibid., 7-5, 7-7.
16. Ibid., 7-7, 7-13.
17. Sir Julian Corbett, *Some Principles of Maritime Strategy*. (London: 1911), 261-3.
18. Maritime Administration. "Top 25 Flags of Registry." Accessed 15 December 2011. <http://marad.dot.gov>.
19. U.S. Energy Information Administration, "China Analysis," Revised 22 April 2013, <http://www.eia.gov/countries/cab.cfm?fips=CH>.
20. Hayley Dixon, "Rules of Cyber Warfare Set Out for First Time in NATO Manual," *The Telegraph*, 19 March 2013, <http://www.telegraph.co.uk/technology/9939401/Rules-of-cyberwar-set-out-for-first-time-in-Nato-manual.html>.
21. United States Department of the Navy. *The Commander's Handbook on the Law of Naval Operations*. Naval Warfare Publication (NWP) 1-14M. Quantico: Navy Warfare Development Command, July 2007. 8-17.
22. Richard Crowell, "War in the Information Age: A Primer for Cyberspace Operations in 21st Century Warfare," *Naval War College*. June 2012. 7, 14.
23. Kenneth Christopher, *Port Security Management* (Boca Raton: Auerbach Publications, 2009),. 261.
24. Dr. Wolff Heintschel, "Cyberspace and International Law" (lecture, Naval War College, Newport, RI, 14 March 2013).
25. Ibid.
26. United States Department of the Navy. *The Commander's Handbook on the Law of Naval Operations*. Naval Warfare Publication (NWP) 1-14M. Quantico: Navy Warfare Development Command, July 2007. 5-2,3.
27. Dr. Wolff Heintschel, "Cyberspace and International Law" (lecture, Naval War College, Newport, RI, 14 March 2013).
28. Maritime Transport Network Portal, Accessed 2013, www.mtnet.gov.tw.
29. Ibid.
30. Ibid.
31. US-China Business Council, "US-China Trade Statistics and China's World Trade Statistics," Accessed 2013, <https://www.uschina.org/statistics/tradetable.html>.

32. Liang Yiwen, "China-Flagged Ships Favored," *People's Daily Online*, Accessed 7 March 2012, <http://english.peopledaily.com.cn/90778/7750325.html>.
33. United States Department of the Navy. *The Commander's Handbook on the Law of Naval Operations*. Naval Warfare Publication (NWP) 1-14M. Quantico: Navy Warfare Development Command, July 2007. 7-12.
34. Tunnel2funnel, "War Risk Clause in Marine Insurance," Accessed 10 December 2012, www.tunnel2funnel.com/2012/12/war-risk-clause-in-marine-insurance.html.
35. Ibid.
36. Yong-An Park & Francesca Medda, "Classification of Container Ports on the Basis of Networks," *Academia.edu*. Accessed 2013, http://www.academia.edu/854882/CLASSIFICATION_OF_CONTAINER_PORTS_ON_THE_BASIS_OF_NETWORKS. Figure 2.
37. Charette, Robert. "Will GPS Jamming Cause Future Shipping Incidents?," *IEEE Spectrum* (blog), 22 February 2012, <http://spectrum.ieee.org/riskfactor/aerospace/satellites/ship-accident-in-english-channel-due-to-gps-jamming-inevitable>.
38. Ibid.
39. Eric Bland, "GPS Spoofing Could Threaten National Security," *NBCNews.com*. http://www.nbcnews.com/id/26992456/ns/technology_and_science-science/t/gps-spoofing-could-threaten-national-security.
40. Ibid.
41. Edwin Kee, "North Korea GPS Jamming Device Has 100km Range," *Ubergizmo.com*. 7 September 2011. <http://www.ubergizmo.com/2011/09/north-korea-gps-jamming-device-has-100km-range>.
42. Phrack, "Low Cost and Portable GPS Jammer," *Phrack*. <http://www.phrack.org/issues.html?issue=60&id=13>
43. "Global Navigation and Space Systems: Reliance and Vulnerabilities," *The Royal Academy of Engineering*, March 2011. 15. http://www.raeng.org.uk/news/publications/list/reports/RAoE_Global_Navigation_Systems_Report.pdf
44. William Cole, "Report Details Port Royal's Grounding," *Navy Times*. 7 July 2009.
45. Charette, Robert. "Will GPS Jamming Cause Future Shipping Incidents?," *IEEE Spectrum* (blog), 22 February 2012, <http://spectrum.ieee.org/riskfactor/aerospace/satellites/ship-accident-in-english-channel-due-to-gps-jamming-inevitable>.

46. Richard Kusiolek, "Markets, Applications, Directions - Asia Pacific's Golden Satellite Era," *Asia Pacific Satellite Communication Council Newsletter*, Q1 2012, 38.
47. Geoffrey Till, "A Changing Focus for the Protection of Shipping," *The Strategic Importance of Seaborne Trade and Shipping: A Common Interest of Asia Pacific*, 2002. 12.
48. Shachar, Bar-On, "China's Real Estate Bubble," *60 Minutes*, 3 March 2013.
49. Milan Vego, "China's Naval Challenge," *Proceedings Magazine*. July 2011. 40.
50. Zeyan Zhang & Miguel Figliozi, "A Survey of China's Logistics Industry and the Impacts of Transport Delays on Importers and Exporters." *Transport Reviews*, 30, 179-194. March 2010. Table 4.
51. Milan Vego, "On Naval Warfare," *Naval War College*. September 2008. 94.

BIBLIOGRAPHY

- Bar-On, Shachar. "China's Real Estate Bubble." *60 Minutes*. 3 March 2013.
- Bland, Eric. "GPS Spoofing Could Threaten National Security." *NBCNews.com*.
http://www.nbcnews.com/id/26992456/ns/technology_and_science-science/t/gps-spoofing-could-threaten-national-security/
- Burke, William. "How the Navy Protects America." *Rochester Democrat and Chronicle*. 24 July 2012. <http://navylive.dodlive.mil/2012/07/26/how-the-navy-protects-america>.
- Charette, Robert. "Will GPS Jamming Cause Future Shipping Incidents?," *IEEE Spectrum* (blog), 22 February 2012, <http://spectrum.ieee.org/riskfactor/aerospace/satellites/ship-accident-in-english-channel-due-to-gps-jamming-inevitable>.
- Christopher, Kenneth. *Port Security Management*. Boca Raton: Auerbach Publications, 2009.
- Cole, William. "Report Details Port Royal's Grounding." *Navy Times*. 7 July 2009.
- Corbett, Sir Julian. *Some Principles of Maritime Strategy*. London: 1911.
- Crowell, Richard. "War in the Information Age: A Primer for Cyberspace Operations in 21st Century Warfare". *Naval War College*. June 2012.
- Dixon, Hayley. "Rules of Cyber Warfare Set Out for First Time in NATO Manual." *The Telegraph*. 19 March 2013. <http://www.telegraph.co.uk/technology/9939401/Rules-of-cyberwar-set-out-for-first-time-in-Nato-manual.html>.
- "Global Navigation and Space Systems: Reliance and Vulnerabilities." *The Royal Academy of Engineering*. March 2011.
- Heintschel, Wolff. "Cyberspace and International Law." Lecture, Naval War College, Newport, RI, 14 March 2013.
- Kee, Edwin. "North Korea GPS Jamming Device Has 100km Range." *Ubergizmo.com*. 7 September 2011. <http://www.ubergizmo.com/2011/09/north-korea-gps-jamming-device-has-100km-range/>
- Koerver, Hans Joachim. "German Submarine Warfare 1914-1918 in the Eyes of British Intelligence." *British National Archives*, May 2012.
- Kusiolek, Richard. "Markets, Applications, Directions - Asia Pacific's Golden Satellite Era." *Asia Pacific Satellite Communication Council Newsletter*, Q1 2012. 18, 36-39.
- "Low Cost and Portable GPS Jammer." *Phrack*. <http://www.phrack.org/issues.html?issue=60&id=13>

Maritime Administration. "Top 25 Flags of Registry." Accessed 15 December 2011, <http://marad.dot.gov>.

Maritime Transport Network Portal. Accessed 2013, www.mtnet.gov.tw.

Ocean Development Strategy Research Study Group. "China's Ocean Development Report" *State Oceanic Administration*. Beijing, PRC: Maritime Publishing House, 2010.

Park, Yong-An & Medda, Francesca. "Classification of Container Ports on the Basis of Networks." *Academia.edu*. Accessed 2013, http://www.academia.edu/854882/CLASSIFICATION_OF_CONTAINER_PORTS_ON_THE_BASIS_OF_NETWORKS.

Peifer, Douglas C. "Maritime Commerce Warfare. The Coercive Response of the Weak?" *Naval War College Review*. Newport: Naval War College Press, Spring 2013.

Robert S. Strauss Center for International Security and Law. *Tanker War*. Accessed 2013, <http://strausscenter.org/hormuz/tanker-war.html>.

Till, Geoffrey. "A Changing Focus for the Protection of Shipping." *The Strategic Importance of Seaborne Trade and Shipping: A Common Interest of Asia Pacific*, 2002.

Tunnel2funnel. "War Risk Clause in Marine Insurance." Accessed 10 December 2012. www.tunnel2funnel.com/2012/12/war-risk-clause-in-marine-insurance.html.

United States Department of the Navy. *The Commander's Handbook on the Law of Naval Operations*. Naval Warfare Publication (NWP) 1-14M. Quantico: Navy Warfare Development Command, July 2007.

US-China Business Council. "US-China Trade Statistics and China's World Trade Statistics." Accessed 2013. <https://www.uschina.org/statistics/tradetable.html>.

U.S. Energy Information Administration. "China Analysis." Revised 22 April 2013. <http://www.eia.gov/countries/cab.cfm?fips=CH>.

Vego, Milan. "China's Naval Challenge." *Proceedings Magazine*, April 2011.

_____. "On Naval Warfare." *Naval War College*. September 2008.

US Department of the Interior. "War in the Pacific: The Pacific Offensive. The Silent Service: Submarines in the Pacific." Accessed 2013. http://www.nps.gov/history/history/online_books/npswapa/extContent/wapa/guides/offensive/sec6.htm.

Yiwen, Liang. "China-Flagged Ships Favored." *People's Daily Online*. 7 March 2012.
<http://english.peopledaily.com.cn/90778/7750325.html>.

Zhang, Zeyan and Figliozi, Miguel. "A Survey of China's Logistics Industry and the Impacts of Transport Delays on Importers and Exporters." *Transport Reviews*, 30, 179-194. March 2010.